



Work Zone Safety

**Guidelines for Construction, Traffic
Maintenance, and Utility Operations**

October 2003

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Introduction

The purpose of this handbook is to present guidelines for work zone traffic control and to supplement basic work zone safety training. This handbook covers the basic requirements of Part VI of the Manual on Uniform Traffic Control Devices (MUTCD) with particular emphasis on short term work sites. These requirements apply to construction, maintenance, traffic, and utility work zones.

This handbook presents information and gives examples of typical traffic control applications for two-lane and multi-lane work zones. This information is intended to illustrate the principles of proper work zone traffic control, but is **not** a standard. Part VI of the MUTCD and the Indiana MUTCD Supplement contain the standards for work zone traffic control.

Worksite traffic control diagrams provide **minimum** requirements, additional traffic control or protection can be added. This manual covers work setups as presented in the INDOT maintenance/traffic management system.

Incident Management Situations

The immediate response to an emergency situation must by necessity make use of available devices and equipment. Given the opportunity, however, longer term emergencies should be treated in a manner similar to other temporary traffic control work sites.

Traffic Control Devices

The following types of traffic control devices are used in work zone traffic control:

- Signs
- Channelizing Devices
- Warning Lights
- Arrow Displays
- Pavement Markings
- Changeable Message Signs

Signs

Signs used in work zone traffic control are classified as regulatory, guide, or warning. Regulatory signs impose legal restrictions and may not be used without permission from the authority with jurisdiction over the roadway. Guide signs commonly show destinations, directions, and distances. Warning signs give notice of conditions along the roadway.

Spacing of Advance Warning Signs

Sign Spacing (feet)						
	25-30 mph	35-40 mph	45-55 mph	Expressway/ Freeway		
A	200	350	500	1,000	√	A
B	200	350	500	1,600	√	B
C	200	350	500	2,600	√	C

Distances shown are approximate. Sign spacing should be adjusted for curves, hills, intersections, driveways, etc., to improve sign visibility.

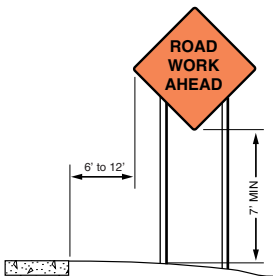
Warning Signs – Construction, maintenance, traffic and utility warning signs are used extensively in street and highway work zones. These signs are normally diamond shaped, having a black symbol or message on an orange background. As a general rule, these signs are located on the right-hand side of the street or highway. Normally, the first advance warning sign used is the ROAD WORK AHEAD sign. The UTILITY WORK AHEAD or WORKERS sign may be substituted where appropriate. Where signs are used to indicate the end of the work zone, the END ROAD WORK or END UTILITY WORK sign may be used as appropriate.

Size – The standard size for advance warning signs in work zones is generally 48 inches by 48 inches. Where speeds and volumes are moderately low, a minimum size of 36 inches by 36 inches may be used (see Part VI of the MUTCD for specific sign sizes). Sign sizes in contract plans or other agency documents may exceed MUTCD minimum requirements and shall be followed.

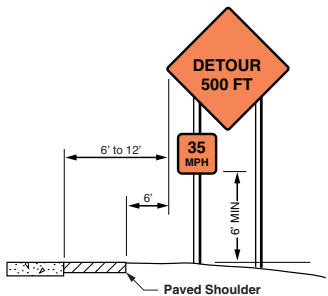
Mounting – Standards for height and lateral clearance of roadside signs are included in Part VI of the MUTCD. Temporary post-mounted signs should be mounted at a height of at least 7 feet, measured from the bottom of the sign. Signs mounted on Type III barricades which close any part of a road or lane should not cover more than 50 percent of the top two rails or 33 percent of the total area of the three rails. Signs mounted on other portable supports or barricades used solely as a sign support may be at lower heights, but the bottom of the sign shall be not less than one foot above the traveled way.

Illumination and Retroreflectorization – All signs used during the hours of darkness shall be made of retroreflective material or illuminated. (Street or highway lighting is not regarded as meeting the requirements for sign illumination.)

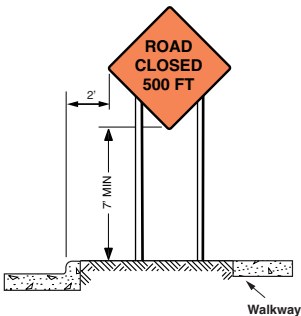
Removal – When work is suspended for short periods, all signs that are no longer appropriate shall be removed, covered, turned, or laid flat so they are not visible to drivers.



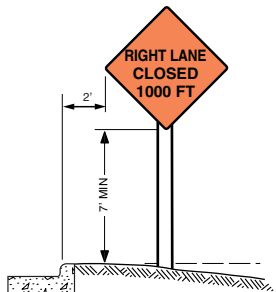
RURAL DISTRICT



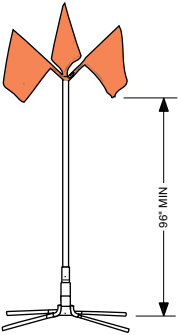
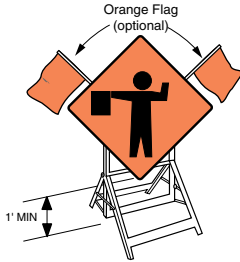
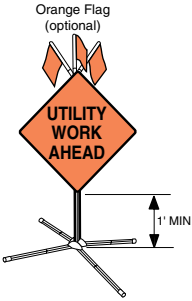
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ADVISORY SPEED PLATE



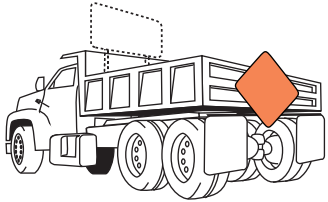
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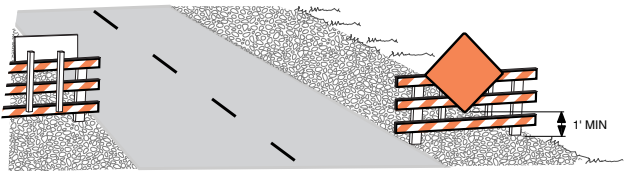
URBAN DISTRICT



HIGH LEVEL WARNING DEVICE
(Flag Tree)

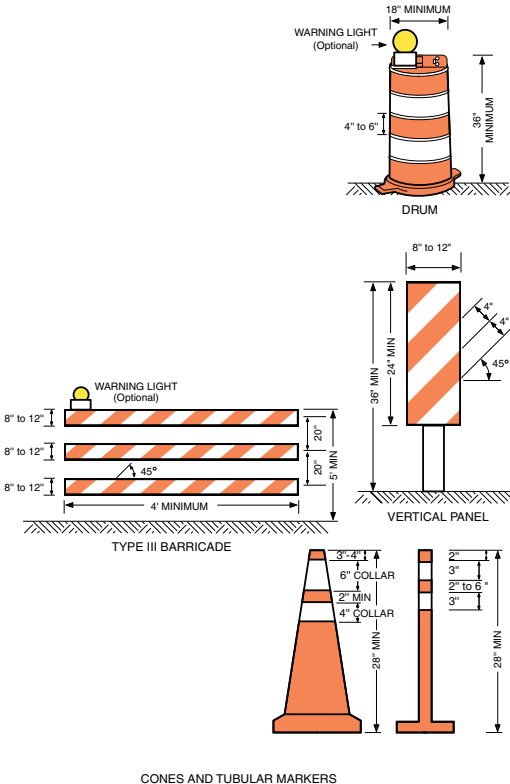


PORTABLE AND TEMPORARY MOUNTINGS



Portable Changeable Message Signs – Portable Changeable Message Signs may be used to supplement other signs, but not to substitute for any required signs. They may display a variety of messages and displays, but are typically only used to display “real-time” or changing condition information. The Changeable Message Sign should not display more than three messages or displays, and the entire message should be readable twice at the usual roadway speed limit.

Channelizing Devices



CONES AND TUBULAR MARKERS

Notes:

1. Stripes on barricade rails slope downward at an angle of 45 degrees toward the direction traffic is to pass.
2. Barricade rail stripe widths shall be 6 inches except where rail lengths are less than 36 inches, then 4 inch wide stripes may be used.
3. The sides of barricades facing traffic shall have retroreflective rail faces.
4. All channelizing devices should meet National Cooperative Highway Research Program (NCHRP) Report 350 Crash Test Requirements.

Channelizing Devices

Channelizing devices are used to warn and alert drivers of conditions in work zones, to protect workers, and to guide and direct drivers and pedestrians safely. Channelizing devices include cones, tubular markers, vertical panels, drums, barricades, and barriers.

Cones are used most commonly for short-duration maintenance and utility work. Cones used at night shall be retro-reflectORIZED as shown on page 5. Drums are used most commonly where they will remain in place for a prolonged period. Ballast shall not be placed on top of channelizing devices.

Spacing

INDOT has adopted a policy of 20 foot spacing between channelizing devices on a two-lane road and 40 foot spacing between channelizing devices on a multi-lane road. Cone and or barrel spacing for straight-a-ways should be:

- At 45 mph & below: 1 cone for every 2 skips
- Above 45 mph: 1 cone for every 3 skips

Warning Lights

Warning lights may supplement retroreflectorization on warning and channelizing devices. They are especially useful in areas prone to fog or frequent inclement weather. Warning lights shall have a minimum mounting height of 30 inches. The principal types and uses of warning lights are:

1. **Low intensity Flashing Lights (Type A)**
May be mounted on barricades or drums to warn of an isolated hazard at night. They may also be mounted on signs.
2. **High intensity Flashing Lights (Type B)**
May be mounted on advance warning signs, or on independent supports to draw attention to extreme hazards both day and night.
3. **Low intensity Steady-Burn Lights (Type C)**
May be used in a series to delineate the edge of the travelway and channelize traffic at night.

The warning light and/or emergency flashers shall be used on vehicles, so equipped, when on the roadway or on the shoulder within 15 feet of the pavement edge and in or near the worksite.

Common Conversions:

1 skip = 10'

Gap between skips = 30'

RPM spacing (No Passing Zone) = 40'

RPM spacing (Passing Zone) = 80'

0.1 mile = 528'

0.2 mile = 1056'

0.3 mile = 1584'

0.4 mile = 2112'

0.5 mile = 2640'

0.6 mile = 3168'

0.7 mile = 3696'

0.8 mile = 4224'

0.9 mile = 4752'

1.0 mile = 5280'

Arrow Displays

An arrow display in the arrow or chevron mode may be used to supplement signs and other devices for lane closures on multilane roadways. An arrow display in the caution mode shall be used only for shoulder work, blocking the shoulder, or roadside work near the shoulder.

Panel Type	Roadway Speed	Min. Size	Min. # Lamps	Min. Legibility Distance
A	25-30 mph	24" x 48"	12	1/2 mile
B	35-40 mph	30" x 60"	13	3/4 mile
C	≥ 45 mph	48" x 96"	15	1 mile

OPERATING MODE

At least one of the three following modes shall be provided:

PANEL DISPLAY*

(Right shown; left similar)

Flashing Arrow



Move/Merge Right

Sequential Arrow



Move/Merge Right



Sequential Chevron



Move/Merge Right



The following mode shall be provided:



Flashing Double Arrow

Move/Merge Right or Left

The following mode shall be provided:



or



Flashing Caution

Caution

*Element layout for Type C Panel shown

Pavement Markings

For long-term stationary projects, follow the guidelines of Part VI of the MUTCD in placing and removing pavement markings. The colors of temporary pavement markings and delineators follow the same standard as for permanent markings. When used to enhance the visibility of the roadway edge, white is specified along both sides of two-way roadways and the right side of one-way roadways. Yellow is used on the left side of one-way roadways. Centerlines and lane lines are yellow when separating opposing directions of traffic and white when separating lanes going the same direction.

Where existing pavement marking conflicts with the temporary travel path, additional signing and channelizing devices are appropriate.

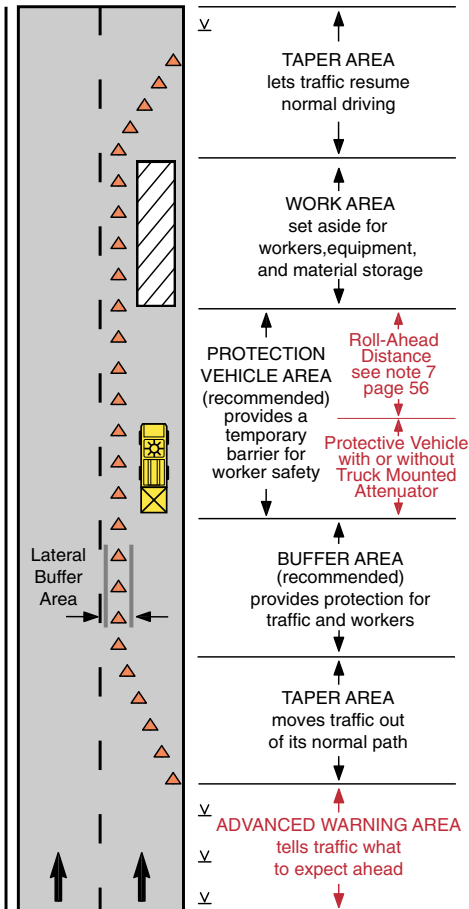
Fundamental Principles

The principles listed below provide a guiding philosophy of good temporary traffic control and enhance the safety of motorists, pedestrians, and workers in the vicinity of temporary traffic control zones.

1. Make traffic safety and temporary traffic control an integral and high-priority element of every project from planning through design, construction, and maintenance.
2. Inhibit traffic movement as little as possible.
3. Provide clear and positive guidance to drivers and pedestrians as they approach and travel through the temporary traffic control zone.
4. Inspect traffic control elements routinely and make modifications when necessary.
5. Pay increased attention to roadside safety in the vicinity of temporary traffic control zones.
6. Train all persons that select, place, and maintain temporary traffic control devices.
7. Establish proper legislative authority to implement and enforce needed traffic regulations, speed zoning, parking controls, and incident management.
8. Keep the public well informed.
9. If there is a sideroad intersection or ramps within the work area, additional traffic control, such as flaggers and appropriate signage, may be needed on the side road approaches or ramps.

Parts of a Traffic Control Zone

The traffic control zone is the distance between the first advance warning sign and the point beyond the work area where traffic is no longer affected. Below is a diagram showing the six parts of a traffic control zone.



Taper Length Criteria for Work Zones

The five types of tapers used in work zone traffic control are:

Type of Taper

1) *Merging Taper* – The number of lanes is reduced on a multilane road

2) *Shifting Taper* – A lateral shift, but no reduction in the number of travel lanes

3) *Shoulder Taper* – The shoulder is closed

4) *Two-way Traffic Taper* – Opposing directions of traffic share one open lane

5) *Downstream Taper* – The work area ends and traffic resumes normal driving (use is optional)

TABLE II: INDOT STANDARD TAPERS

Taper Length	Cone Spacing	Cone Offset	Number of Cones	Description
100'	20'	2'-5"	6	2-Way Tapers
220'	20'	1'-0"	12	Shoulder Tapers
340'	20'	0'-8"	18	Shifting Tapers and Low Speed Merging Tapers
780'	40'	7"	21	Multi-Lane Road Merging Tapers

Buffer Lengths

The buffer area is a recommended part of the work zone. It serves to separate traffic flow from the work area or a potentially hazardous area and provides recovery space for an errant vehicle. The buffer area should not include any work activity nor storage of equipment, vehicles or material.

Guidelines for Buffer Lengths

Speed (mph)	Length (ft)	Speed (mph)	Length (ft)
20	35	45	220
25	55	50	280
30	85	55	335
35	120	60	415
40	170	65	485

A lateral buffer space may also be used to separate passing traffic from the work area. Its use and width is based on conditions at the work site.

Supervisor's Checklist

1. Have a traffic control plan before going to the work site.
2. Ask yourself, "What is the driver's view of the work site—at night, during peak hours, etc."
3. Investigate crashes/incidents to identify if changes are needed in the traffic control plan.
4. For overhead work, traffic control is required for affected lane(s).

Planning the Layout

The key to good traffic control is to apply the guidelines using proper judgment. Consider factors such as duration of work, location of work, and characteristics of the roadway.

Duration of Work

Work duration is a major factor in determining the number and types of devices used in temporary traffic control zones. As a general rule, the longer the operation will last, the more traffic control devices are needed. Also, as the work time is short, the time during which motorists are affected is significantly increased when additional devices are installed and removed. Considering these factors, it is generally held that simplified control procedures are warranted for short-duration activities. Such shortcomings may be offset by the use of other, more dominant devices, such as special lighting units on work vehicles.

Long-Term Stationary – Work that occupies a location more than 3 days.

Intermediate-Term Stationary – Work that occupies a location from overnight to 3 days.

Short-Term Stationary – Daytime work that occupies a location for 1 to 12 hours.

Short Duration – Work that occupies a location up to 1 hour.

Mobile – Work that moves intermittently (stops up to 15 minutes) or continuously.

Location of Work

The choice of traffic control needed for a temporary traffic control zone depends upon where the work is located. As a general rule, the closer the work is to traffic, the more control devices are needed.

What Traffic Control Set-Up Should I Use?

These five questions should be considered and answered in order to provide proper worksite traffic control.

1. What is the type of road (two-lane or multi-lane) on which we will be working?
2. Are we working on the roadway or shoulder?
3. How long will we be at a location?
4. Is extra protection needed?
5. Is the open lane a minimum of 10' wide? (restricted lanes require channelizing devices and signs)

Curvy and Hilly Locations

These locations may require extra work zone safety measures.

Night Time Traffic Control

Extra care should be taken when scheduling work at night. Plan ahead whenever possible, involving all affected personnel, to ensure that everyone understands what is expected of them and that you have the proper traffic control equipment for the job. As stated on page 1 of this manual, the immediate response to an emergency situation must by necessity make use of available devices and equipment. Given the opportunity, however, longer term emergencies should be treated in a manner similar to temporary traffic control as soon as possible. If you are setting up a Long Term Stationary or Intermediate Term Stationary work-zone you can consult the Manual on Uniform Traffic Control Devices (MUTCD) for guidance.

The work-zone controls mentioned in this manual are the minimum requirements and extra controls should be utilized when needed. Closing additional lanes when possible and the use of message boards are just 2 of the tools available.

Typical Application Diagrams












The diagrams on the following pages represent examples of the application of principles and procedures for safe and efficient traffic control in work zones but are not intended to be standards. It is not possible to include illustrations to cover every situation which will require work area protection. These typical layouts are not intended as a substitute for engineering judgment and should be altered to fit the conditions of a particular site. Contract plans or other agency documents may also have applicable layouts to be followed.

The diagrams are not to scale, and the number of channelizing devices shown may not be the number needed at the work site. Work vehicles are not shown in diagrams. Use the tables on the typical diagrams to determine taper and buffer lengths, and use pages 6 and 11 for guidance on the spacing and number of devices.

The notes and tables on the typical diagrams provide important information for the user.

Read all notes before using these diagrams. The information presented in these diagrams and tables are generally minimums. For further information, refer to Part VI of the MUTCD and the Indiana MUTCD supplement. These contain the standards for work zone traffic control.

Legend

	Channelizing Device		Protection Vehicle with Flashing Light
	Arrow Board Display		High Level Warning Device
	Flagger Symbol		Work Area
	Portable Sign Support		Warning Sign
	Arrow Board Display Symbol		Protection Vehicle with Truck-Mounted Attenuator (TMA)
	Changeable Message Sign		

Protection vehicle for INDOT shall be a dump truck loaded with sand and parked at an angle. If a TMA is used, the truck shall be loaded per TMA manufacturers specifications, parked parallel to traffic, front wheels angled away from traffic, and may be either a dump or 2 ton stakebed vehicle. Drawings are not to scale. The drawings do not depict the number of channelizing devices to use.

Definitions of Terms

Shall - a mandatory condition. Where certain requirements in the design and application of the device are described with the “shall” stipulation, it is mandatory when an installation is made that these requirements be met.

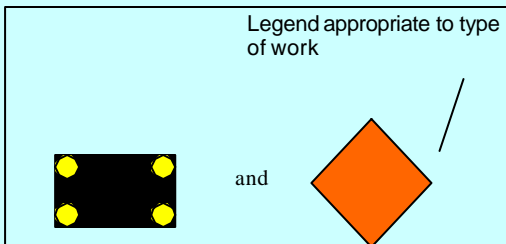
Should - an advisory condition. Where the word “should” is used, it is considered to be advisable usage, recommended but not mandatory.

May - A permissive condition. No requirement for design or application is intended.

Not for INDOT use - Not for use on INDOT roads.

Supplemental Notes to the October 2003 Work Zone Safety Manual

- On page 26, add “LEFT LANE CLOSED XX m(FT)” sign between signs A and B. Use spacing B for the distance between this sign and the others.
- On page 58, the arrow board and sign symbols will be replaced (with a sticker placed over the existing symbols) as follows:



- On page 63, arrow board symbols will be added (with stickers) next to the two protection vehicles that don't have them.

